Correlation signals of jet-medium interaction are not an artifact!

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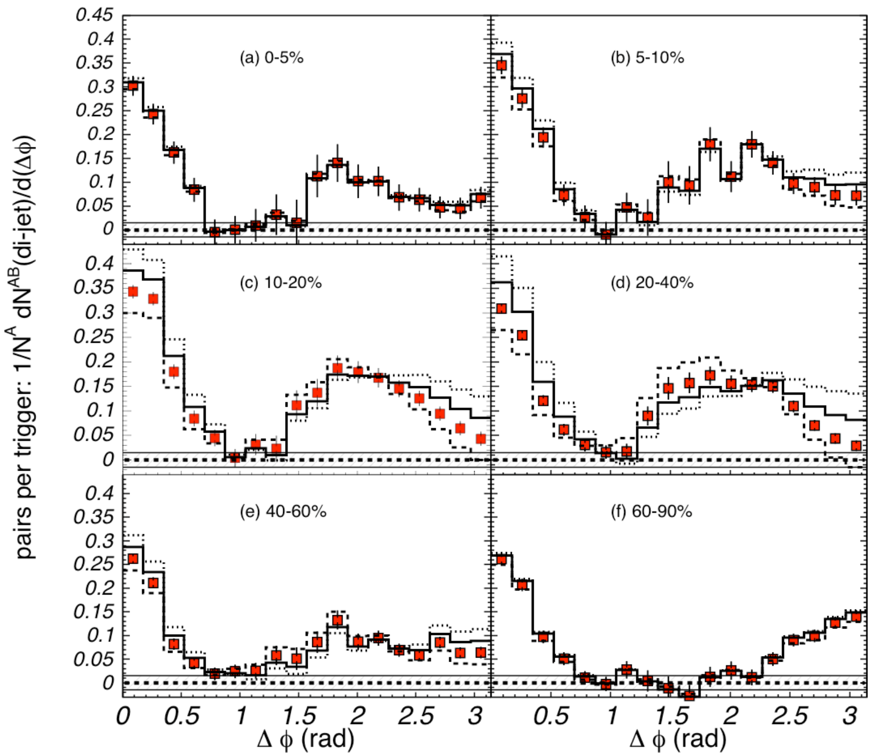
IN THE CITY OF NEW YORK

Prelude

The organizers asked me to talk about "ZYAM subtraction". Since all that needs to be said about ZYAM can be said on one or two slides, I took this to mean:



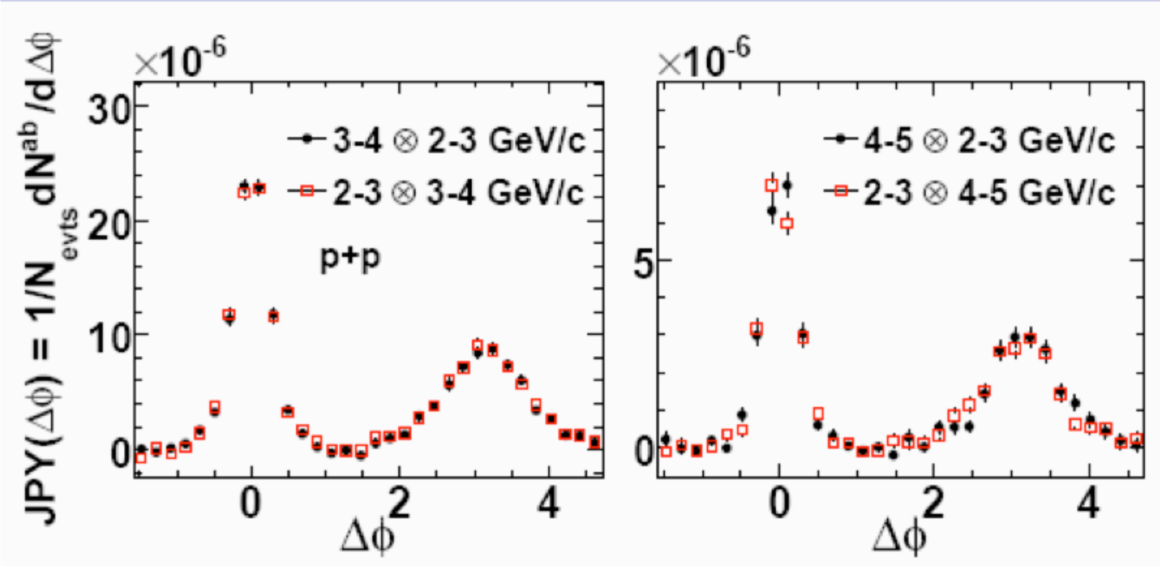
Are these away-side structures of the jet-pair distribution real or an artifact of the decomposition procedure?

As you can guess from the title,

My answer is: yes they are real!

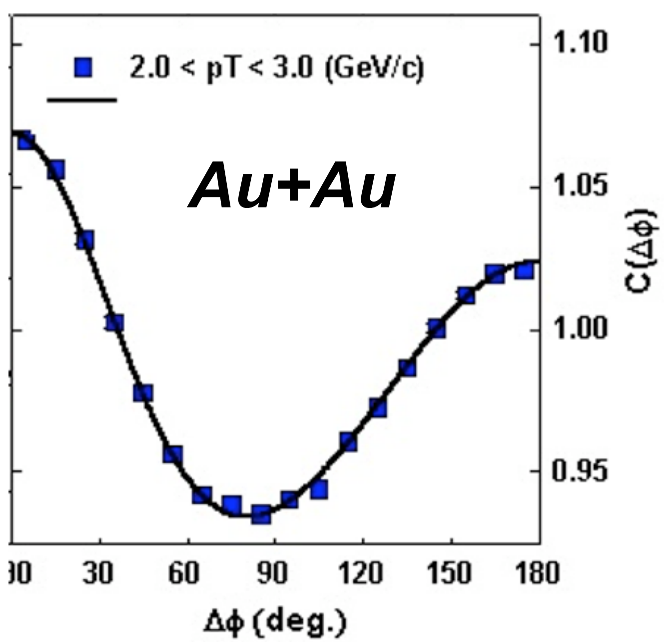
… the reasoning follows …

The Need for Decomposition



Jet ➡ asymmetry

p+p (and d+A) underlying event small compared to jet signal assumed to be largely uncorrelated



Flow ➡ anisotropy

Jet ➡ asymmetry

A+A underlying event large compared to jet signal and has strong harmonic modulation due to flow!

Need to decompose the correlation function
In order to reveal the jet-pair distribution!

The Two Source Model

Most analyses assume the two source model, i.e. only two sources of correlation:

1) Jet correlations
2) Harmonic underlying event

$$C(\Delta\phi) = b_0 H(\Delta\phi) + J(\Delta\phi)$$

background normalization

harmonic background

jet function

The harmonic modulation of the background due to flow can be measured.
If the background level b0 can be fixed, obtain jet function via subtraction

Two Main Methods for Estimating the Background Level

Zero Yield At Minimum (ZYAM):

N.N. Ajitanand et al,
Phys. Rev. C 72, 011902 (2005)

Motivated from p+p: assume that there is some phi minimum where the jet pair distribution has no yield

$$J\left(\Delta\phi_{\min}\right) = 0$$

But we know that there is an underlying event in p+p (it's small and does not translate into a large uncertainty on A+A ZYAM)
-> Pretty good assumption
(robust shape extraction, yields are lower limit yields)

Absolute background normalization:

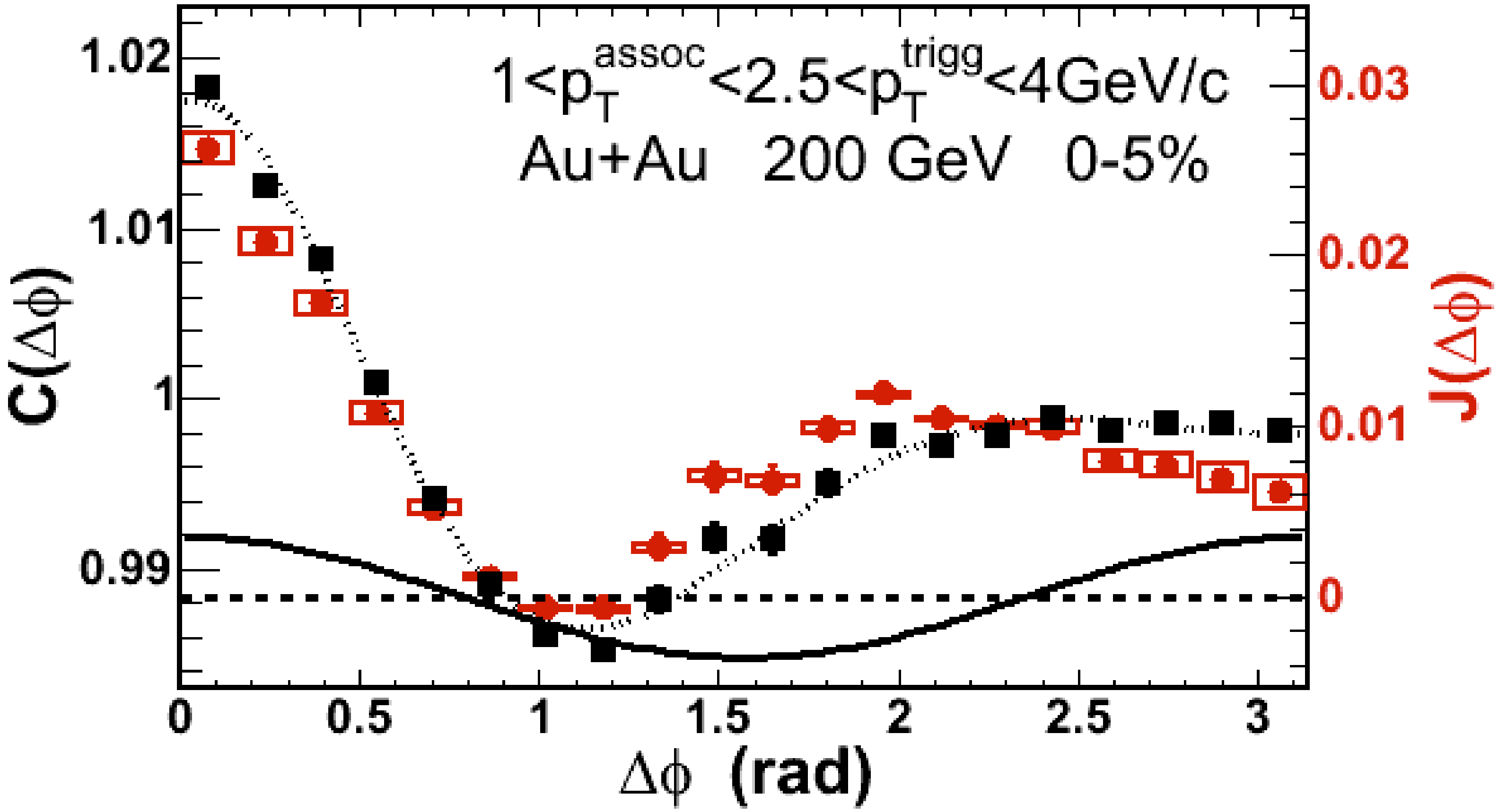
Number of combinatorial background pairs are estimated from number of trigger and associated partner particles

$$n_{AB} = n_A n_B \times (correction - factor)$$

Has its own set of assumptions and Systematic uncertainties (details: see Mike McCumber's talk this workshop)

Both methods essentially agree to w/i systematic uncertainties !

A Closer Look at ZYAM



Pretty clear that any v2, here, will give you a dip at $\Delta\phi=\pi$! We know there is a finite v2 in 0-5% events -> comprehensive flow analyses at RHIC!

Dip will be present even if ZYAM is violated by any reasonable assumption!

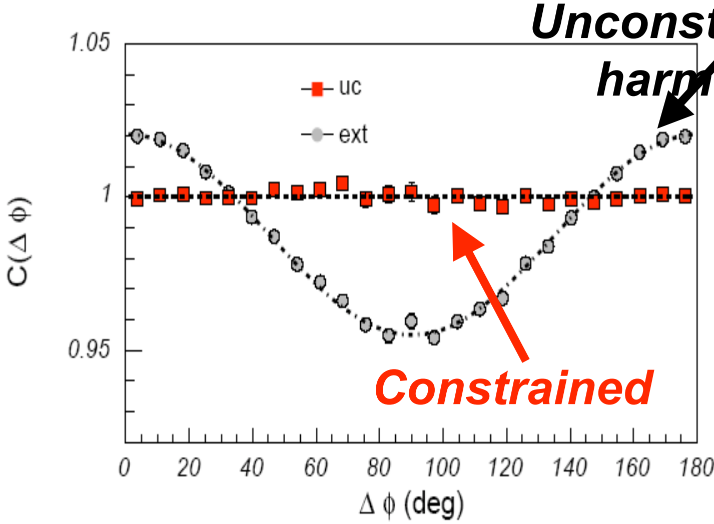
Much more sensitive to right magnitude of harmonic modulation!

You don’t need to subtract flow!

… just extinguish it instead!

Data

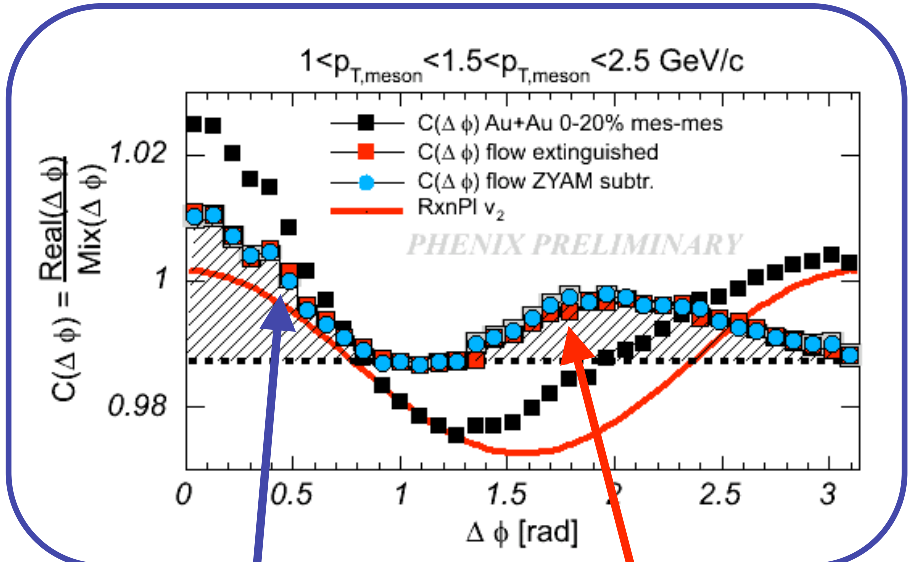
High pt particle constrained perpendicular to RP



Operational Demonstration

vary $\Delta\phi_c$ Constraint byte

untill $v_2^{out} \sim 0$



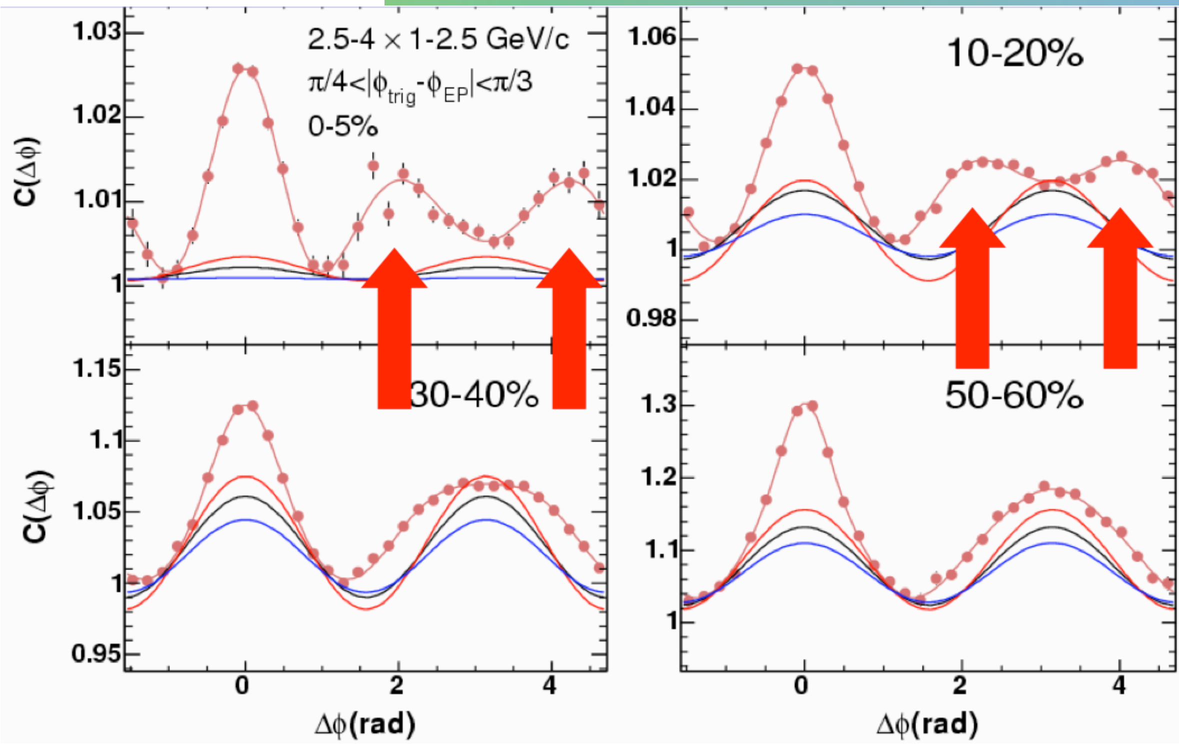
ZYAM subtracted $J(\Delta\phi)$

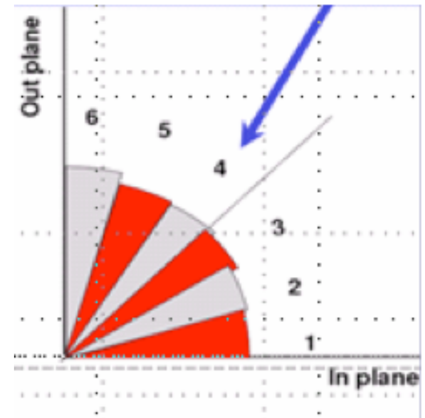
Flow extinguished $C(\Delta\phi) = J(\Delta\phi)$

Methods Agree Remarkably Well!

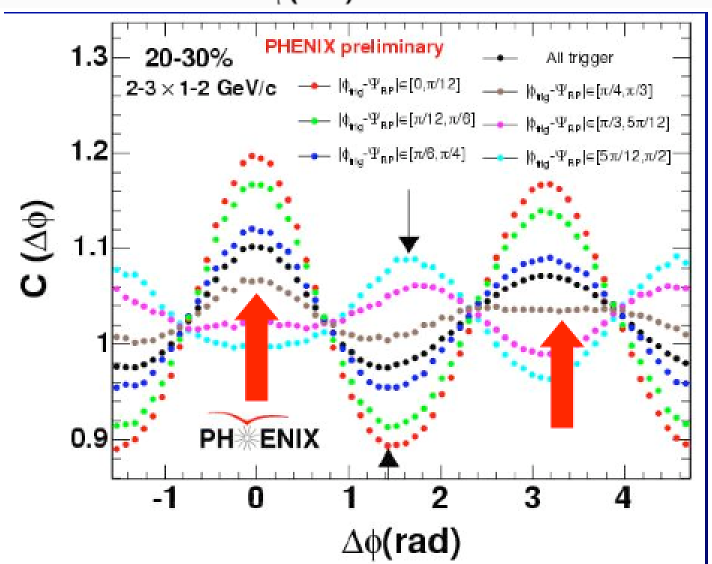
This works because of our relatively poor event plane resolution with the BBC

More Insights from Reaction Plane Dependent Correlations



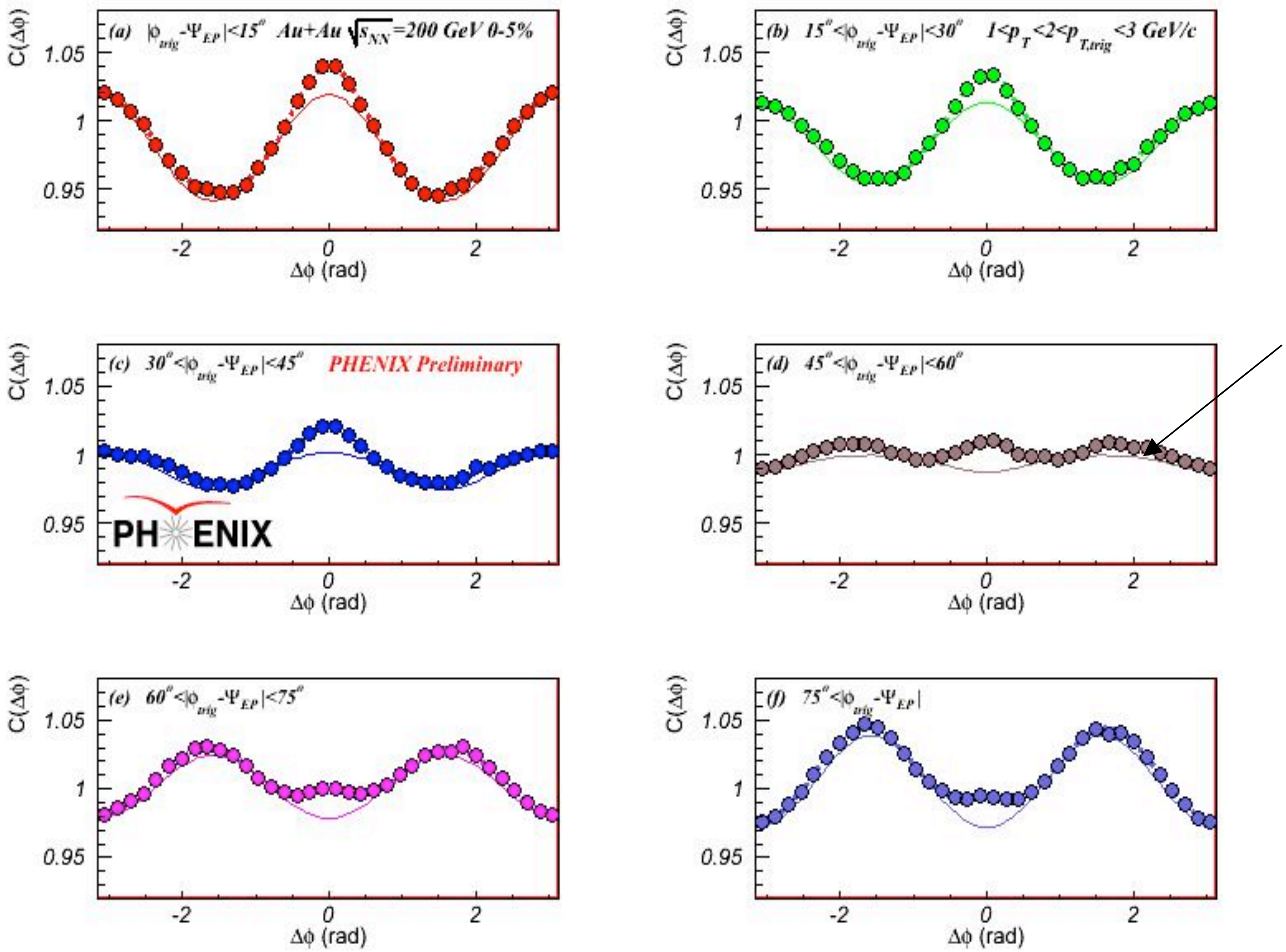


Bin 4 has smallest v2 contribution!



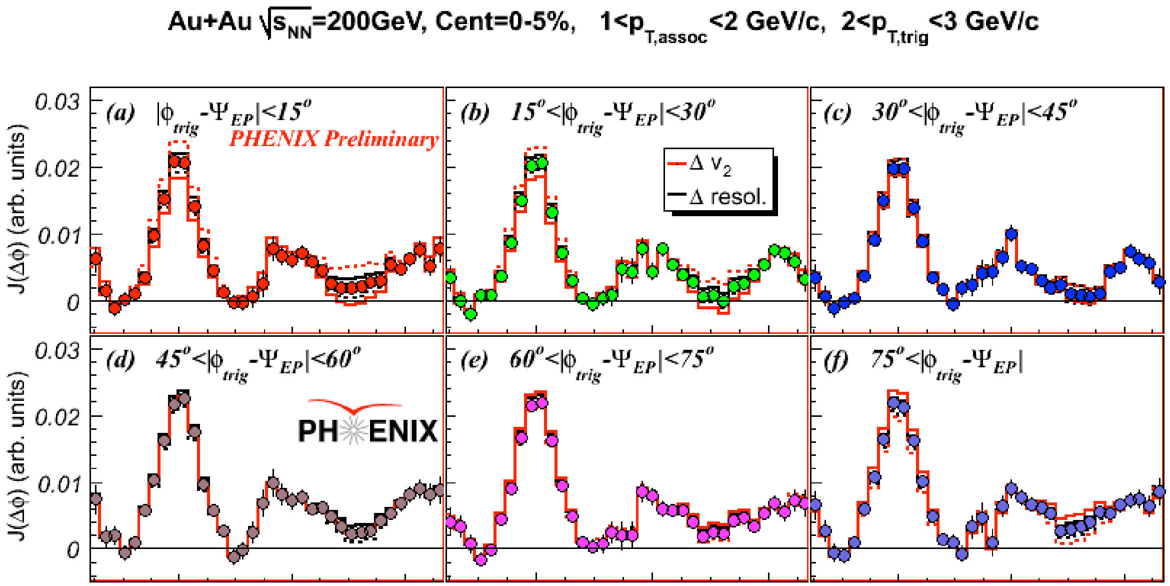
Presence of displaced away-side peak not dependent on flow subtraction!

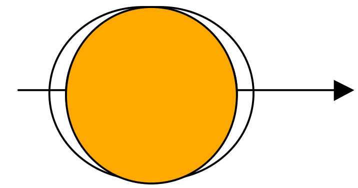
Run7 - RxNP Detector gives Much better Resolution



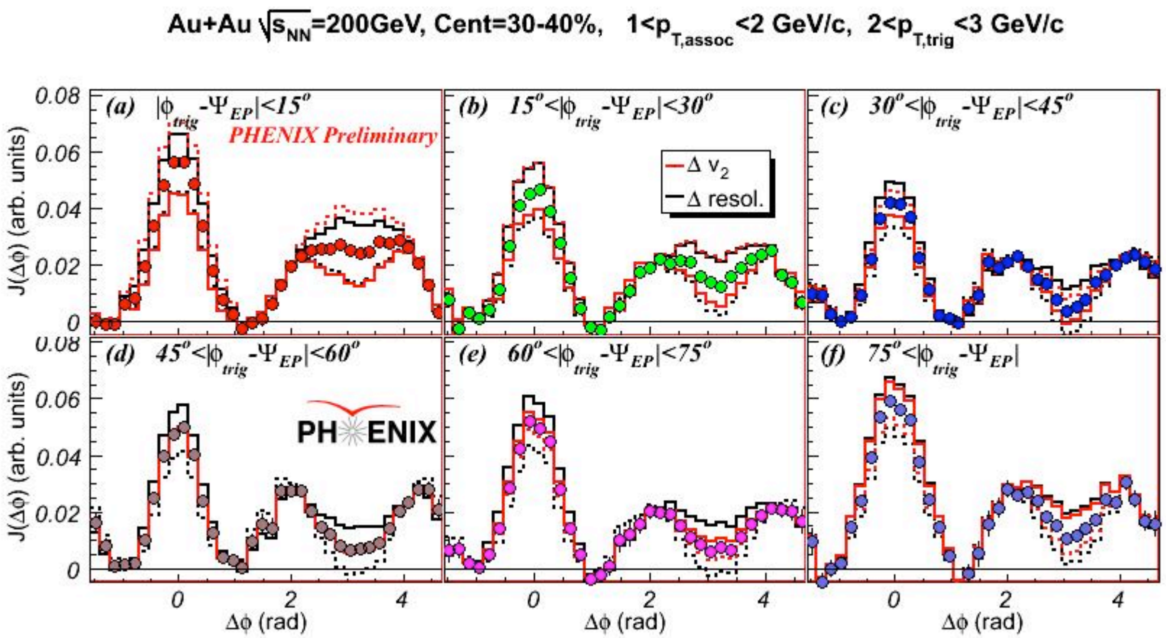
Not optimal plot for this purpose, but again the same message

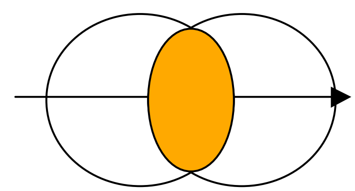
Run7 - RxNP Detector gives Much better Resolution





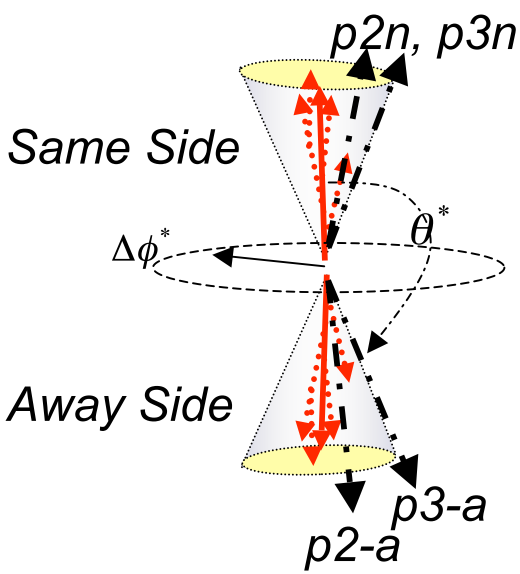
Magnitude of flow signal being subtracted is very different in all bins
-> excellent agreement





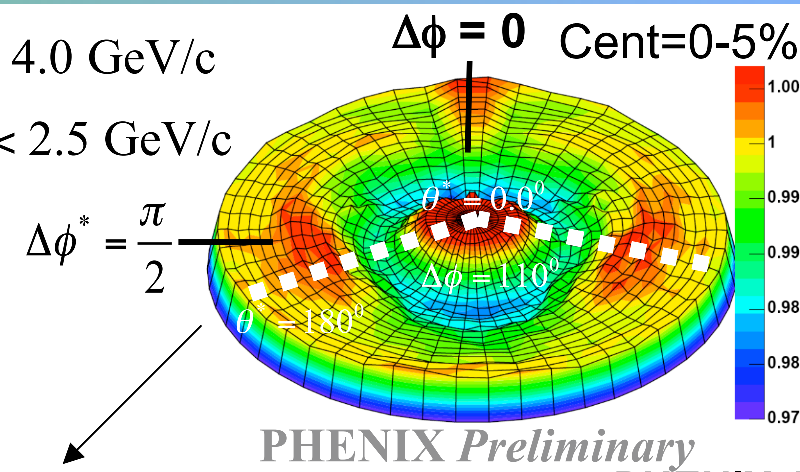
Now have sensitivity to changes of jet function with geometry!

Three Particle Correlations



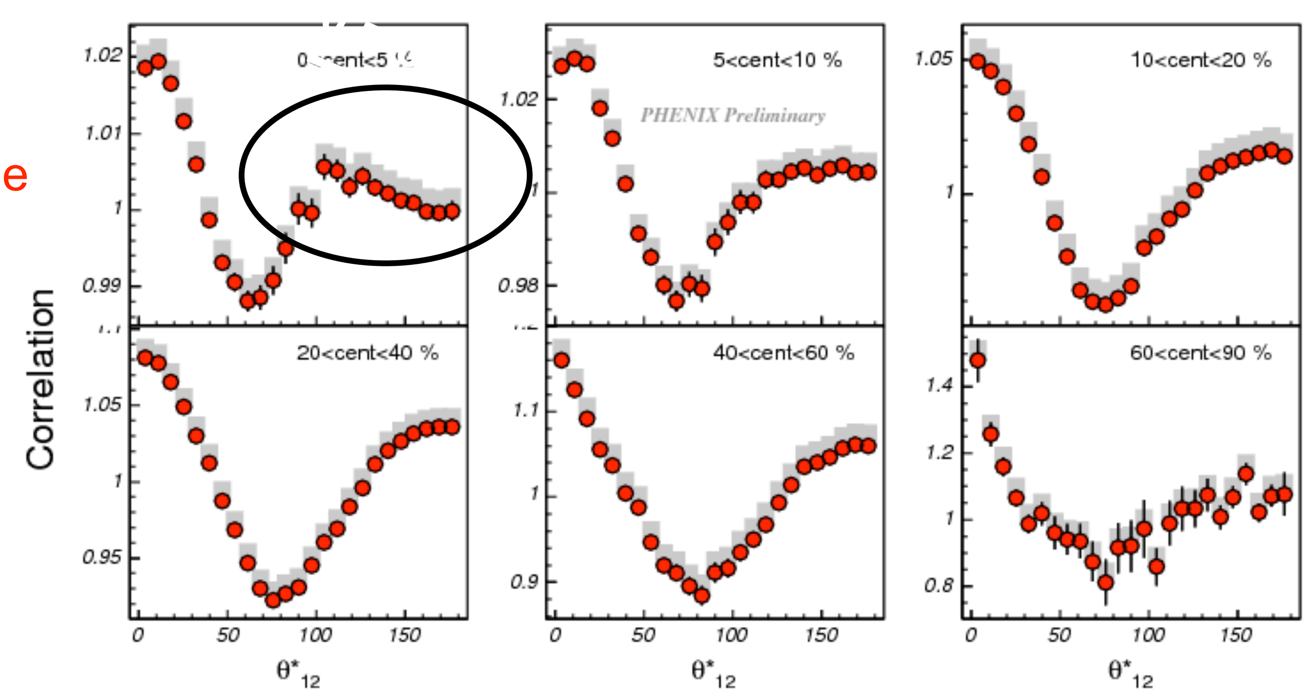
$2.5 < p_T^{trig} < 4.0$ GeV/c

$1.0 < p_T^{assoc} < 2.5$ GeV/c

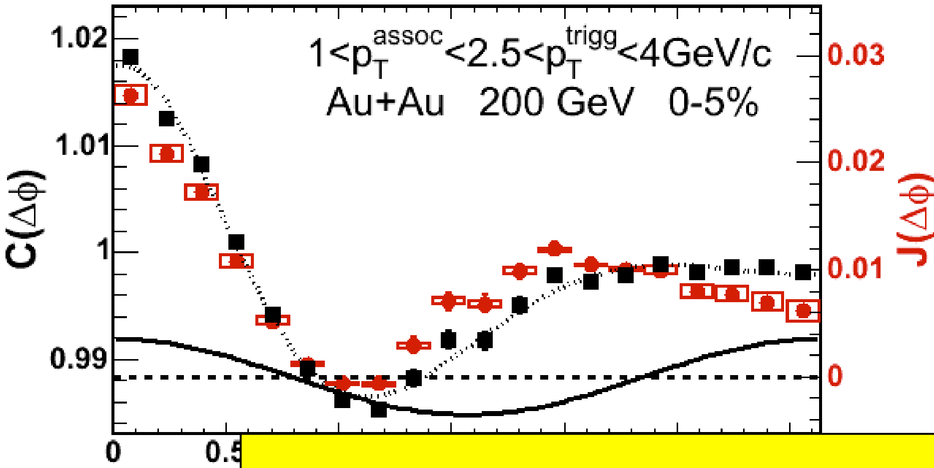


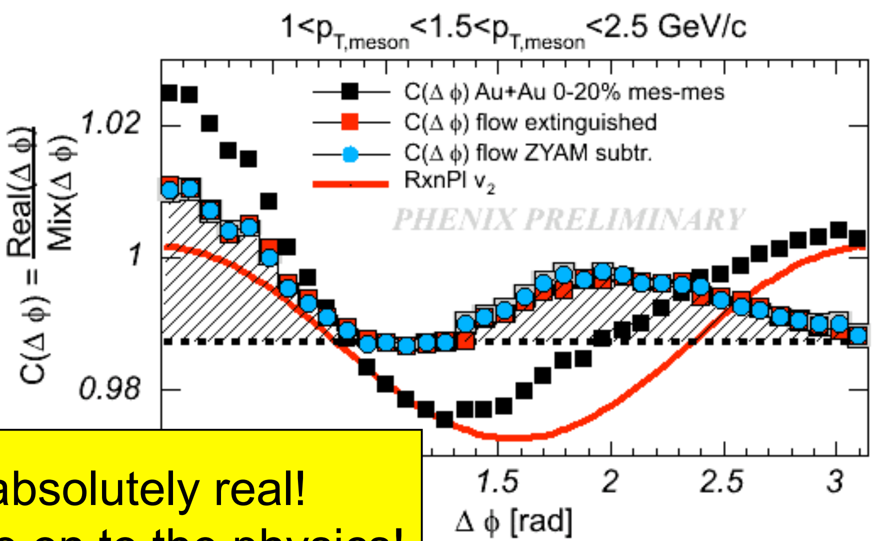
Uncorrected, NO v_2 subtraction

Displaced away-side peaks seen w/o flow subtraction also in 3-particle correlations!

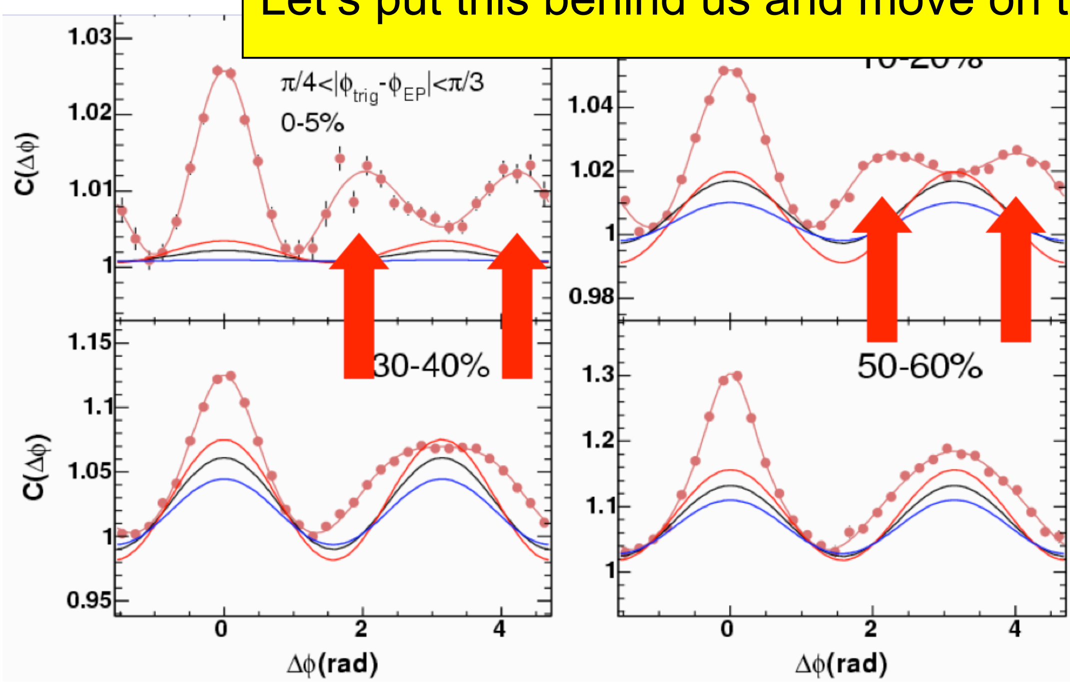


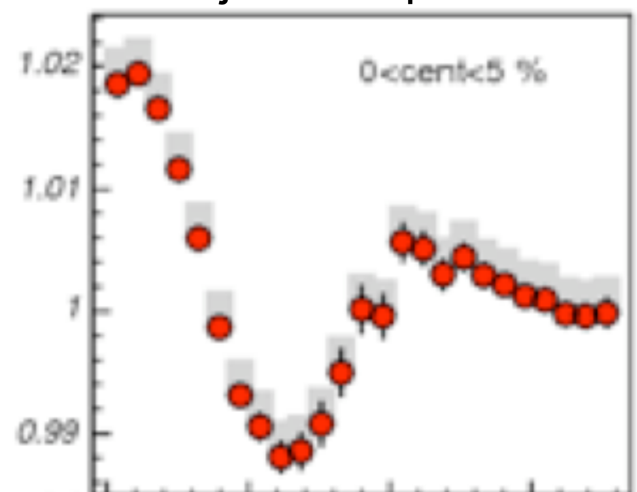
Summary





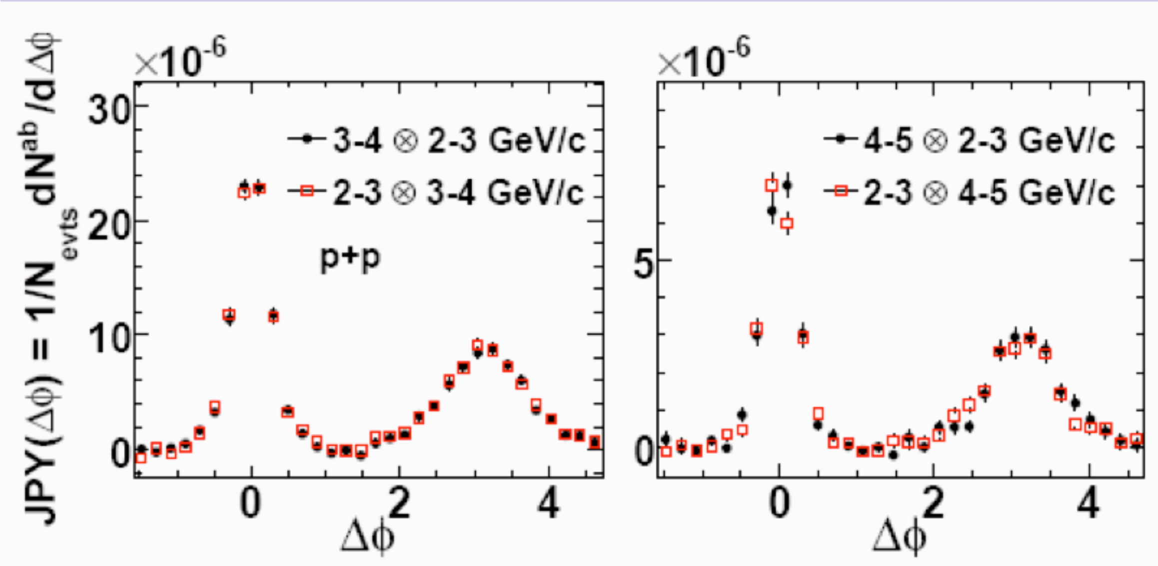
Mach-cone like signals are absolutely real!
Let's put this behind us and move on to the physics!

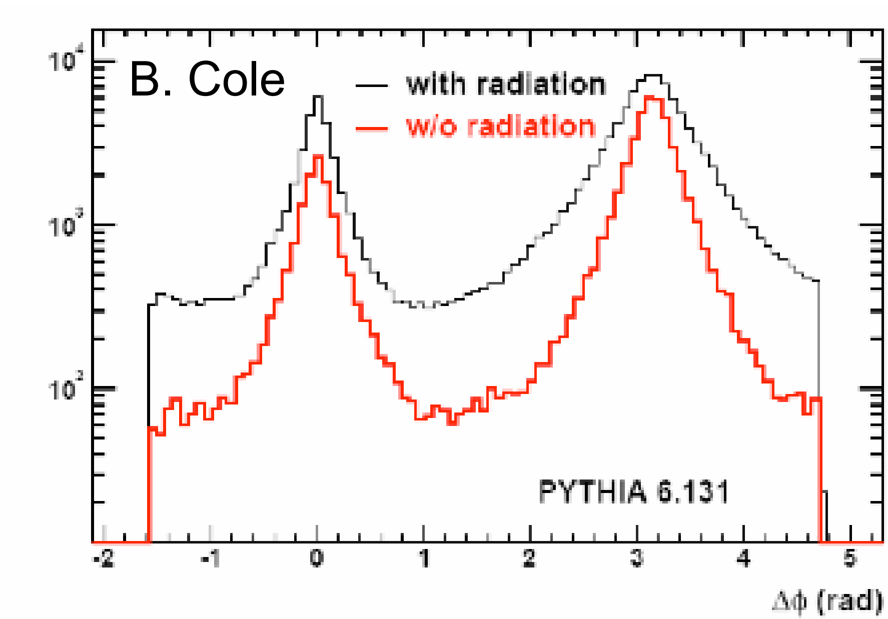




BACKUP

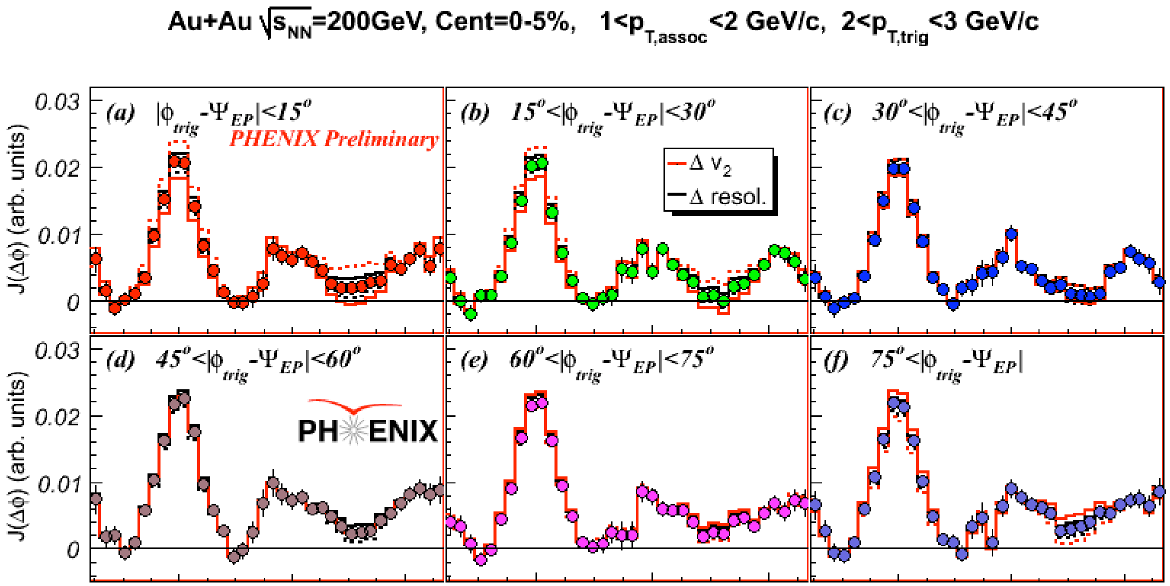
ZYAM Assumption

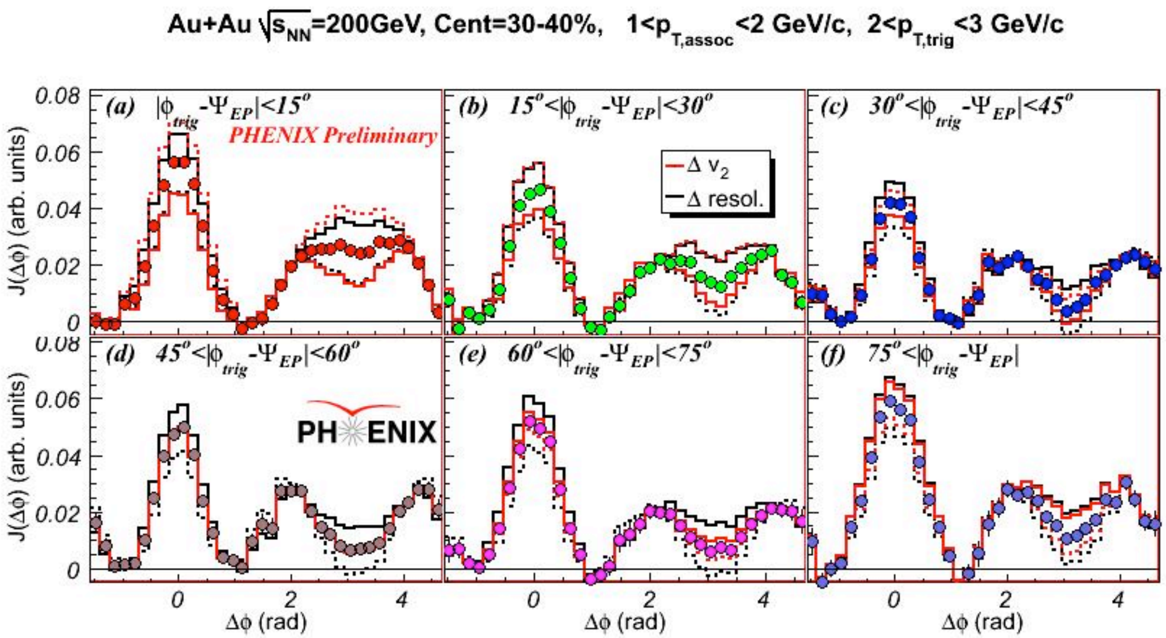




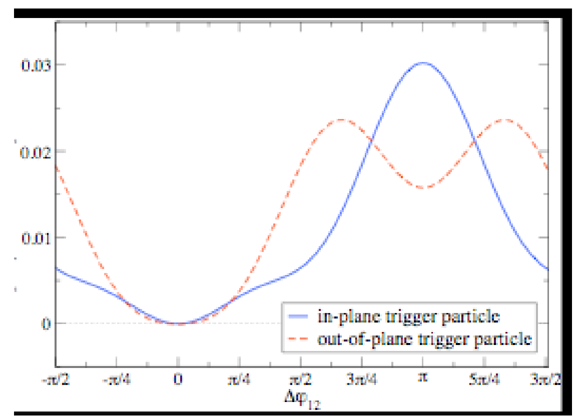
No real ZYAM point even in p+p but pair yield from underlying event is small compared to jet signal.
In A+A jet signal is small compared to background. ZYAM assumption a good approximation!

Momentum Conservation?



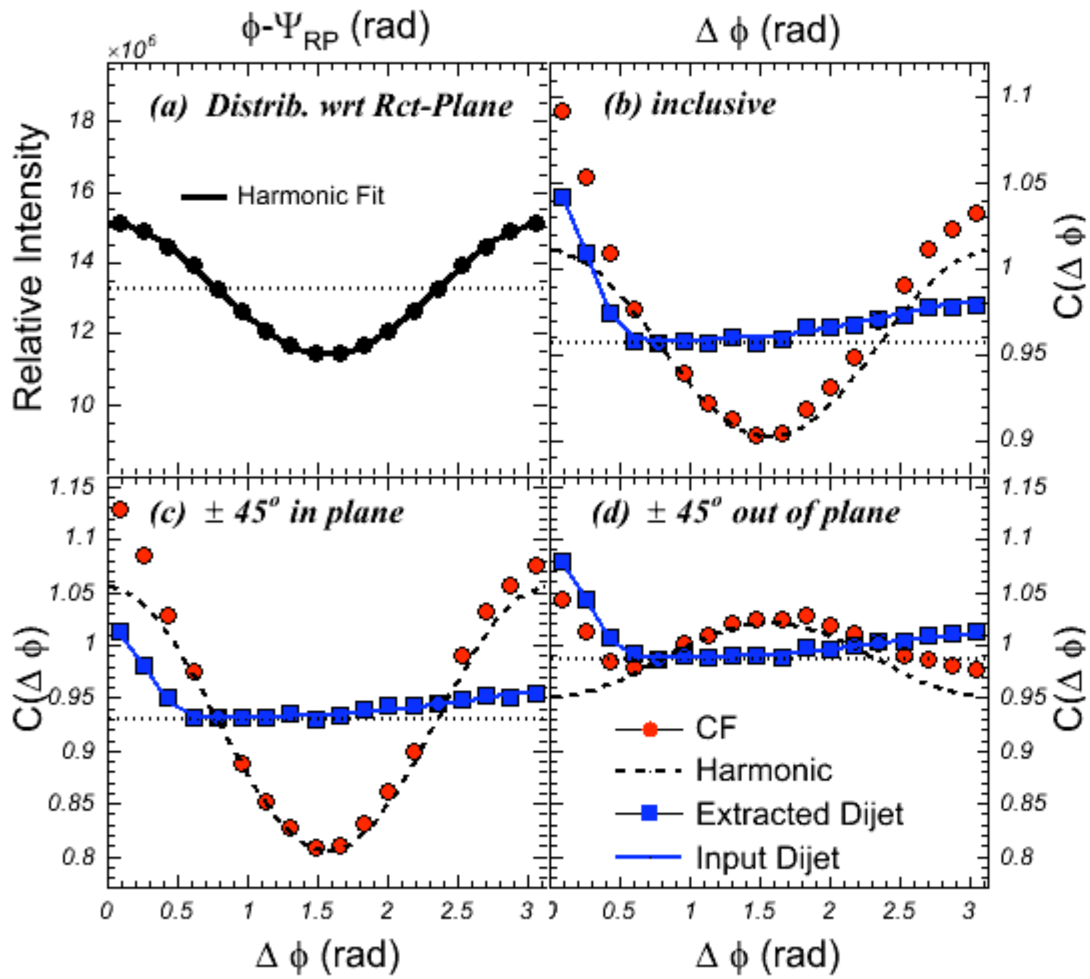


Borghini arXiv:0710.2588



I blieve that the possibility that the entire away-side structure is due to mom. cons. Is highly unlikely

Simulation test of ZYAM Ansatz



Input jet faithfully recovered!